Spatial Fishery Property Rights and Marine Zoning: A Discussion with Reference to Management of Marine Resources in New England

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Introduction

- **Economists have long recommended the assignment of property rights to the fishery as a means to internalize the stock externality that leads to rent dissipation**
- **However, there is less agreement, and little research on the optimal nature of property rights for fisheries.**
- **Although spatial regulations such as closed areas and spatial gear restrictions are quite common, little attention has been paid to whether and when spatial attenuations of property rights for fisheries are likely to be desirable.**

Introduction

- **Optimal property rights systems for some fisheries must, like terrestrial property rights, pay explicit attention to space.**
- **SURF + TURF = T-SURF or perhaps “Surf-n-turf”**
- **Zoning regulations may be required to minimize conflicting uses and coordinate activities across fisheries and user groups to achieve system wide objectives that generate public goods.**
- **Examples from New England fisheries are used to illustrate a variety of welfare reducing problems that may not be resolved by conventional ITQ systems but might with spatially explicit property rights or zoning.**

An unfinished history of property rights theory for fisheries

- **H. Scott Gordon (1954) illustrates the inefficiencies that result from a lack of property rights to a fish stock and argues that a monopolist would choose an intensity of effort coincident with the social optimum.**
- **Christy (1973) suggests and Clark (1980) shows formally that, under certain conditions, the benefits of sole ownership can be achieved by allocating transferable shares of the surplus production from a fishery to individual users in the form of individual transferable quotas (ITQS).**

An unfinished history of property rights theory for fisheries

- **Spatial delineation of fishery rights (TURFs) may provide another means to internalize stock externalities (Christy 1982)**
- **Except in the case of some sedentary species, TURFs fail to fully internalize the stock externality unless they are extensive enough to cover the full geographic range of the fishery or fisheries concerned.**
- **TURFS become even more problematic if they grant use rights to all fisheries in an area.**

An unfinished history of property rights theory for fisheries

- **While ITQs have been shown to internalize stock externalities in the case of a continuous and spatially homogeneous fishery, there are a variety of reasons to believe that ITQs will not yield an efficient outcome relative to sole ownership.**
- **These include:**
  - **seasonal depletion and congestion externalities (Clark 1980, Boyce 1992).**
  - **heterogeneity in unit harvest costs or resource value (Gordon 1954, Sanchirico and Wilen 2002).**
  - **suboptimal age structure of catch (Smith 1969)**
  - **multispecies issues**

Beyond the Sole Owner

- **A second class of harmful effects is likely to be external to even the sole owner of a fishery.**
- **These include**
  - **bycatch,**
  - **cross-fishery congestion externalities,**
  - **habitat destruction, and**
  - **actions that reduce non commercial benefits derived from the marine environment (e.g., existence value of marine mammals and marine recreational opportunities).**

The Unit Fish Stock

- **Stock assessments and harvest guidelines are typically based on the concept of a unit fish stock.**
- **Hilborn and Walters (1992) note that "any natural stock that is large enough to be of management interest will consist of a highly heterogeneous collection of individuals with different sizes, ages, growth rates, movement patterns, reproductive abilities, behaviors in response to fishing gear, and risks of mortality."**
- **Potential harm of other organisms and habitat may also vary across these substocks.**
- **Both the value of animals harvested and the unit cost of harvesting them may vary over space.**

Confronting Spatial Heterogeneity

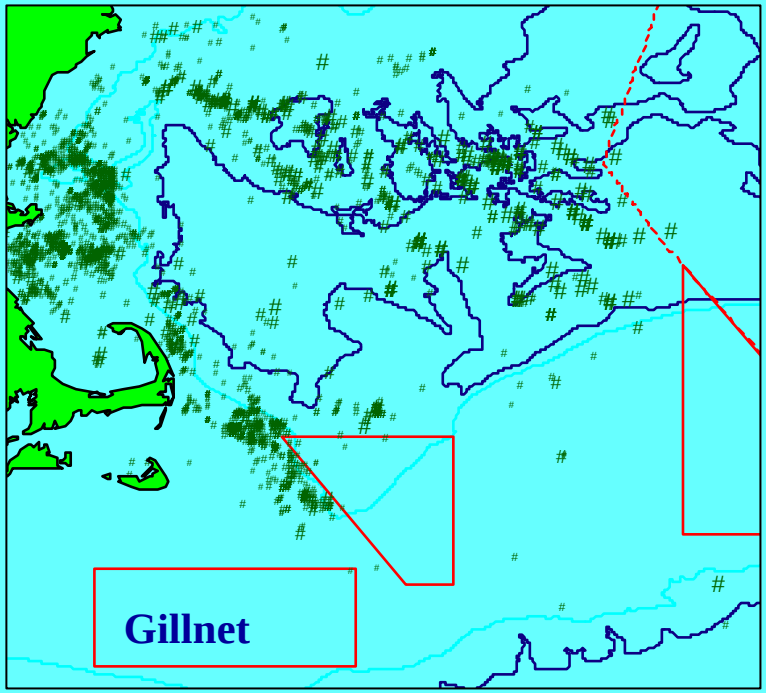
- **This spatial heterogeneity presents both problems and opportunities for fishery management.**
- **There is a growing tendency to use area closures (year-round or seasonal) as a means to capitalize on spatial heterogeneity to reach management goals.**
- **Although they are highly popular with biologists and ecologists (NCEAS 2001), economists have questioned whether closed areas are a useful management tool in an optimally managed fishery (Hannesson 1998).**

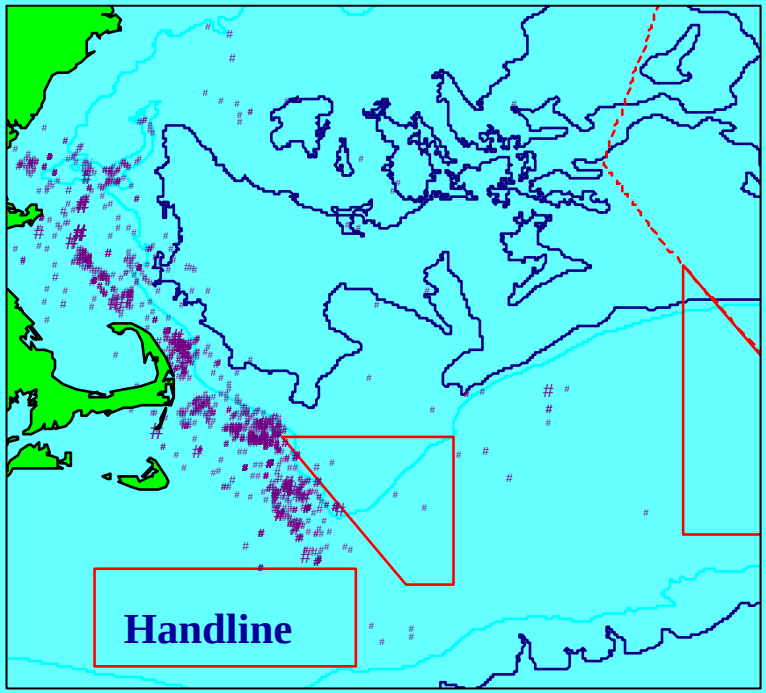
Capitalizing on Spatial Heterogeneity

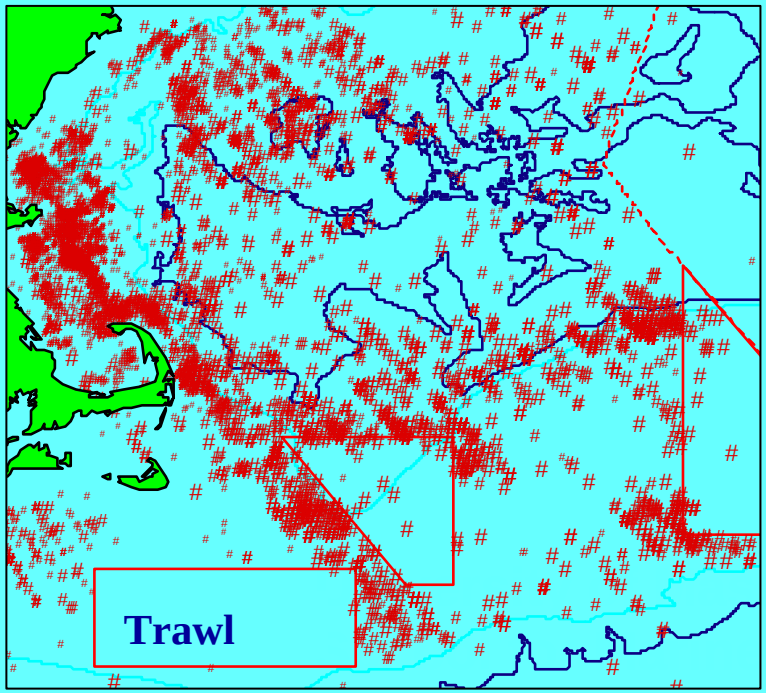
- **There may, in fact, be few cases where complete closures will benefit "well managed" fisheries, but there are likely to be reasons to control the spatial distribution of fishing effort, harvest and gear used.**
- **Our level of understanding of spatial processes in fisheries is increasing rapidly, and technological advances have made implementation and enforcement of spatial rights and regulations feasible and more cost effective.**

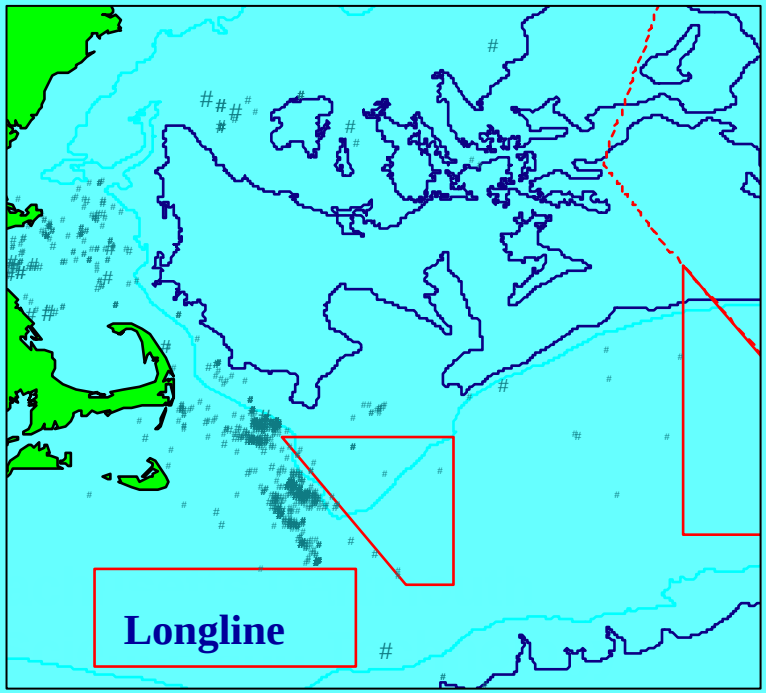
Congestion Externalities

- **A proposal was made in 1915 (Alexander et al. 1915) to segregate otter trawl and fixed gear fishing for groundfish in the Gulf of Maine in part to avoid gear conflicts and in part to avoid habitat damage in sensitive areas.**
- **There is some anecdotal evidence of congestion externalities, particularly in the form of gear conflicts, in the Northeast groundfish fishery.**









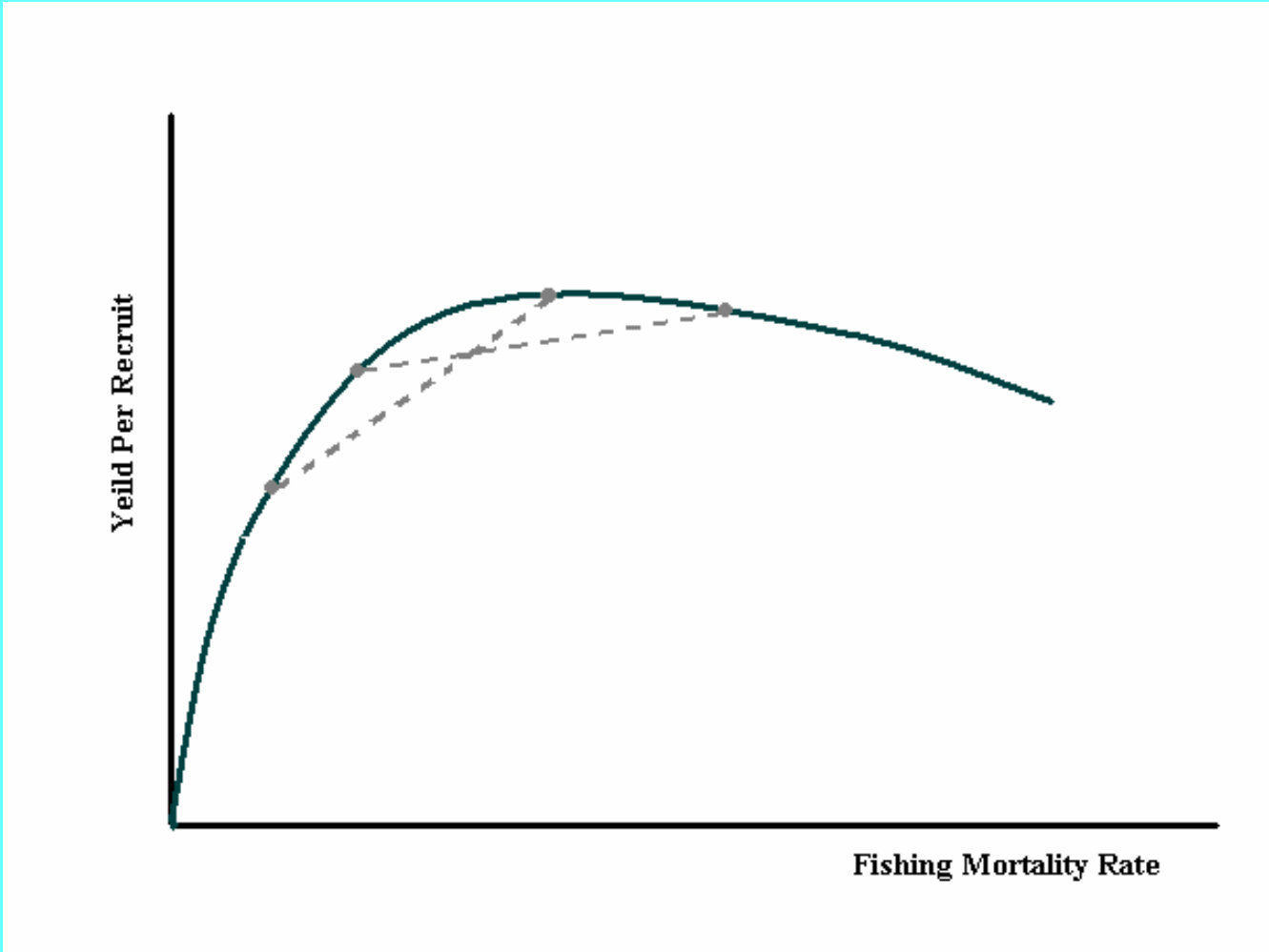
Distribution of 2001 groundfish trips by gear.

Overlap in areas fished by fixed and mobile groundfish gears suggests the possibility of congestion externalities.

Anecdotal evidence suggests limited problems.

Concave Yield Curves

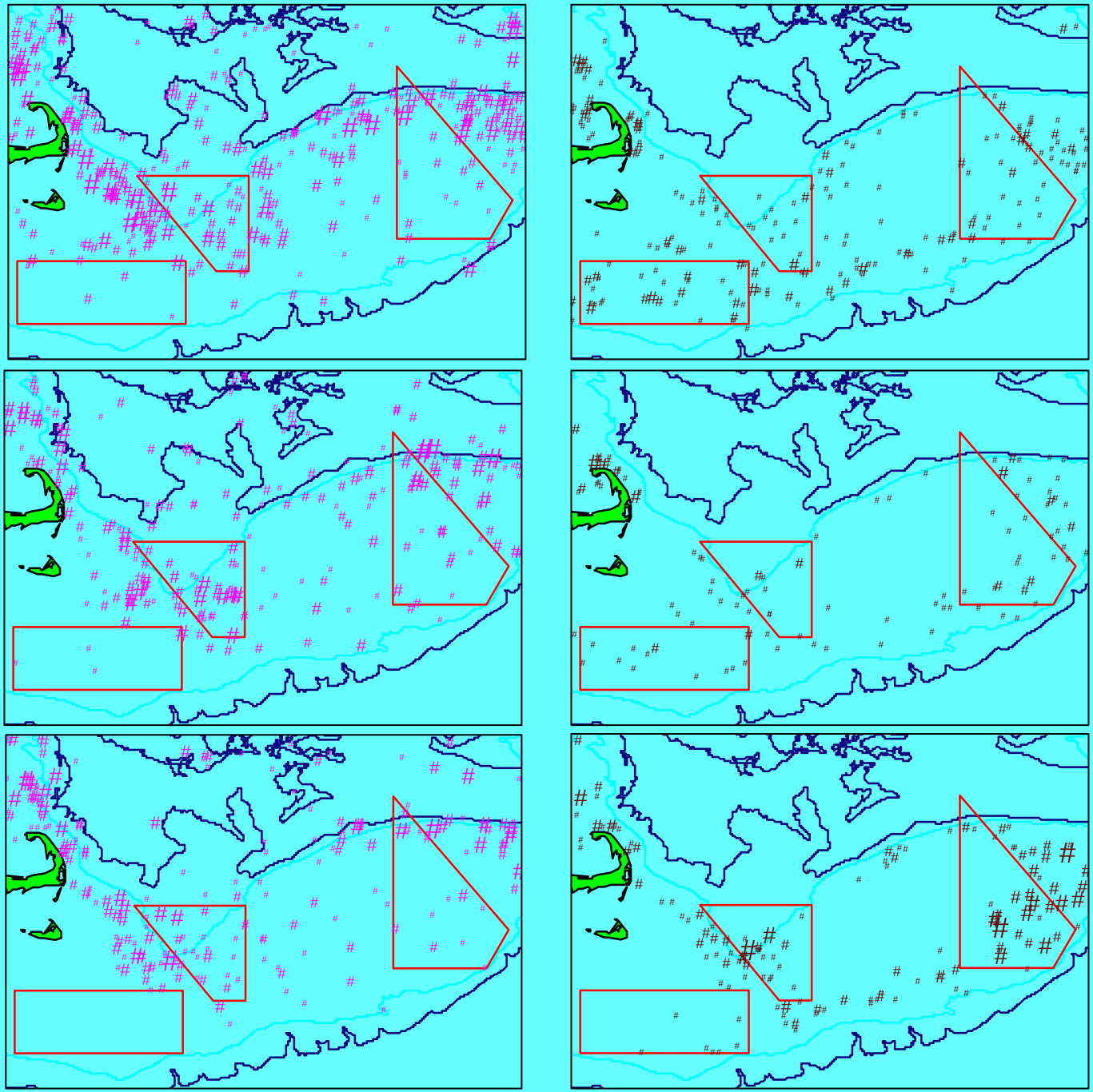
- **Although some fish species are highly mobile and their distributions dynamic, many species, particularly of shellfish, are relatively sedentary or move over a limited range.**
- **As a result, the concentration of effort in certain areas may reduce the potential productivity of the overall stock.**



A typical concave yield-per-recruit curve which shows the relationship between effort and yield. When a fishery is in equilibrium, this curve can be thought of as a sustainable yield curve. If we consider a fishery divided in space, we can see that any heterogeneous effort distribution in the two areas would result in a lower yield than that which would result from even distribution of effort.

Concave Yield Curves

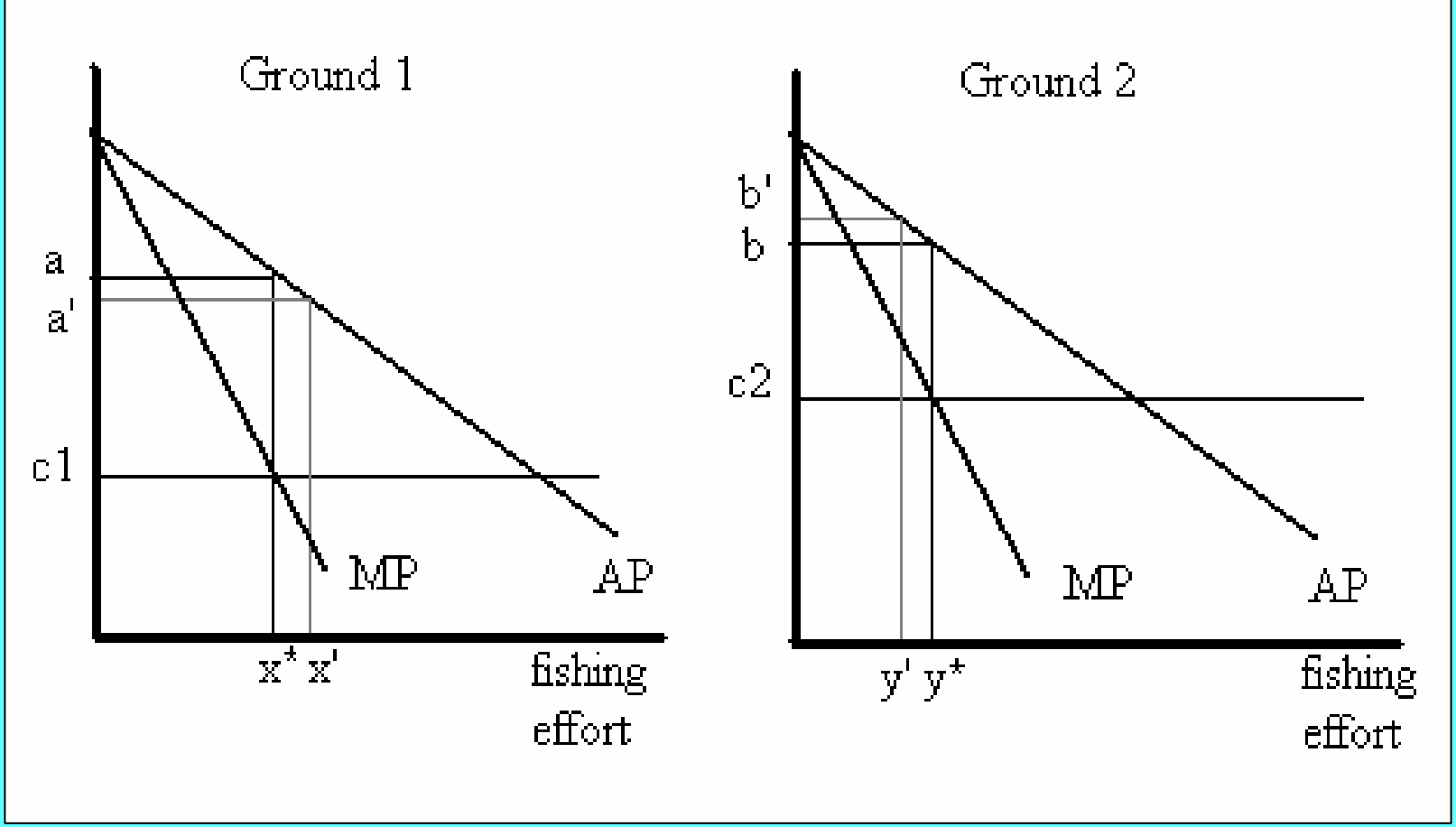
- **For an organism such as the sea scallop which aggregates on relatively discrete beds and exhibits limited movement, it is quite obvious that the spatial distribution of effort will affect the productivity of the overall resource.**
- **Like scallops, some groundfish substocks may be subject to spatially heterogeneous exploitation rates that can reduce overall resource productivity.**
- **Yellowtail flounder on Georges Bank is an excellent example.**



Catch per tow for cod and yellowtail flounder from spring and fall bottom trawl survey tows over three year periods. The smallest dots represent tows with CPUE of 1-5 kg per 30 minute tow. Largest dots represent tows over 75 kg per tow.

Heterogeneous Harvest Costs

- **Consider whether an ITQ system will lead to an efficient outcome (relative to the sole owner) when spatial heterogeneity in the productivity of fishing effort exists either as a result of distance from port, physical fishing conditions that effect gear efficiency or the density of the fish stock.**
- **Following the logic of Gordon (1957) we would expect effort to be distributed so as to equilibrate the average product across grounds which leads to an inefficient distribution of effort.**



In a fishery with two grounds and heterogeneous costs, the optimal distribution of fishing effort and catch will be that which equates net marginal product on the two grounds. This would not be an equilibrium outcome. Optimal management would require setting quotas or taxes explicitly for each area rather than determining a quota or tax for both grounds.

Adjustment of the TAC

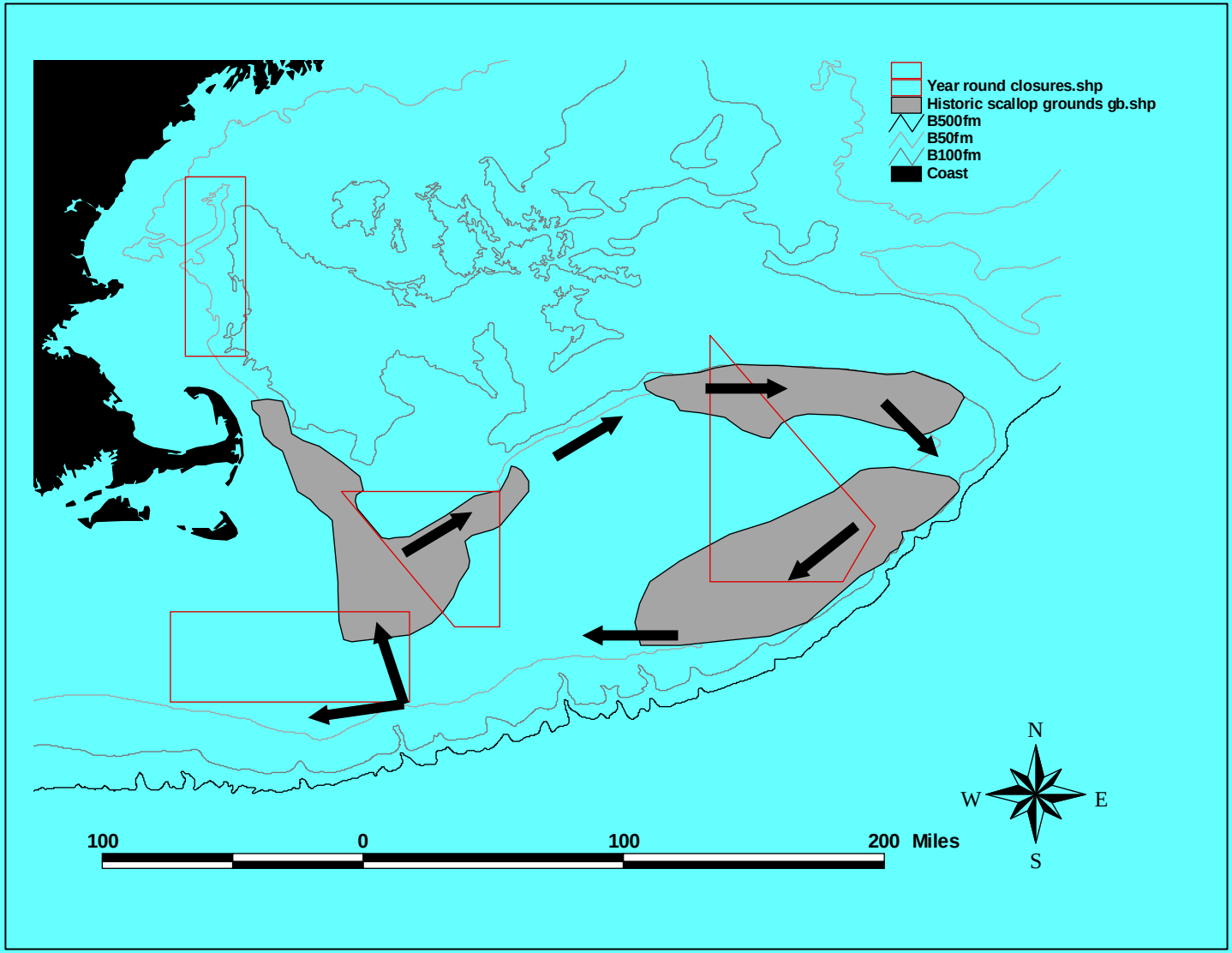
- **Spatially heterogeneous exploitation rates may be desirable when costs are heterogeneous but may also reduces the productivity of the resource.**
- **Rent maximization requires balancing cost factors and resource productivity.**
- **An adjustment must be made in determining the correct overall quota.**
- **Thus the optimal sizes of the total quota and the correct spatial distribution of effort are interdependent and must be solved for simultaneously.**

Serial Depletion

- **It has been suggested that the ability of substocks to regenerate may in some cases be dependent on their own adult populations rather than the overall stock.**
- **Given limited movement of adults, spatial concentration of effort might lead to serial depletions.**
- **The individual fisherman, even in an IFQ holder, might not have the incentive to move to another area if catch rates remain high since they do not incur the full cost of their actions.**
- **Serial depletion may have occurred in the northern cod stock in Canada and may be the reason that stock has not regenerated (Hutchings 1996).**

Source-Sink Processes

- **Source-sink processes may also contribute to suboptimal outcomes in IFQ fisheries.**
- **Consider the example of the scallop fishery on Georges Bank and in Southern New England. It has been hypothesized that recruitment to the scallop grounds to the South and West of Georges Bank is supplemented by reproductive output of scallop substocks on Northeast Georges Bank (Tremblay et al. 1994).**



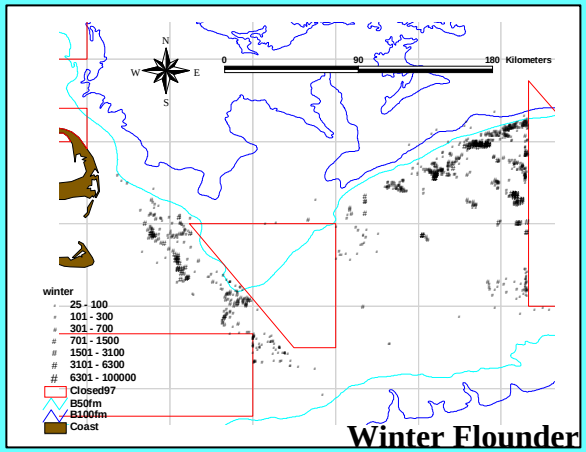
Scallops are historically found in the gray areas. A clockwise gyre tends to advect scallop larvae around the bank and off it to the southwest. Recruitment to various substocks on Georges Bank may be at least partly dependent on other substocks, and Southern New England beds may be dependent on Georges Bank.

Source-Sink Processes

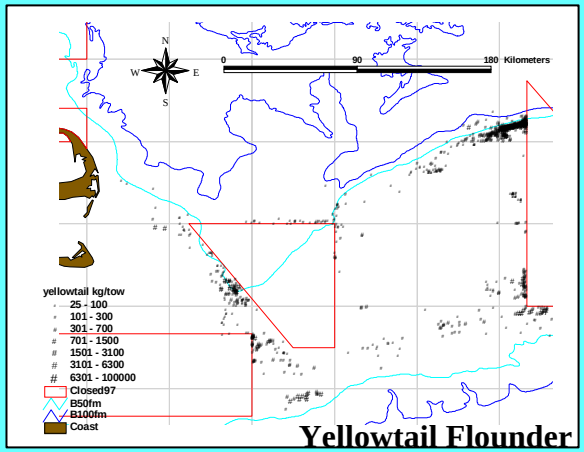
- **It may be beneficial to forgo harvests in some areas in order to increase recruitment in others, particularly if stocks in sink areas have fallen to low levels.**
- **Higher exploitation rates might be justified in areas that are sinks for recruits but do not appear to be sources for other areas.**
- **The absence of good information about the spatial dynamics of recruitment suggests a management strategy that would prevent local depletion of areas which might be reproductive sources.**

Multispecies Fisheries

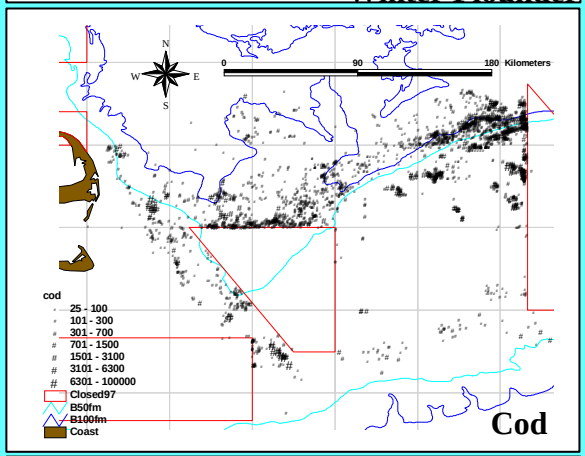
- **Multispecies fisheries can present particular difficulties for ITQ management systems if species are subject to jointness in production.**
- **Quota prices for individual species should adjust to provide incentives for the fleet as a whole to adjust species composition in line with species quotas. However, in some cases it may be more profitable for an individual fisherman to simply discard certain species rather than land them and pay for quota.**
- **The problem is analogous to high grading in a single species fishery.**



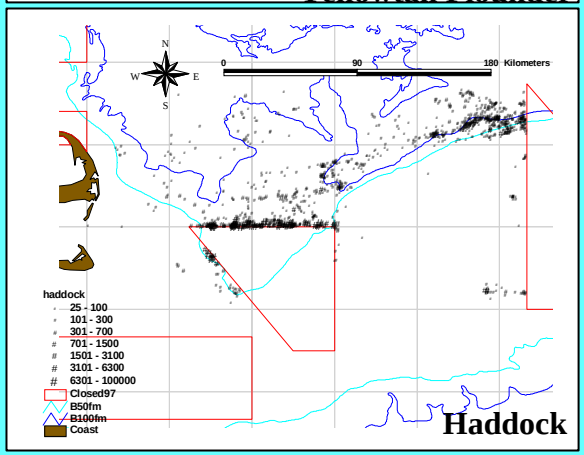
Winter Flounder



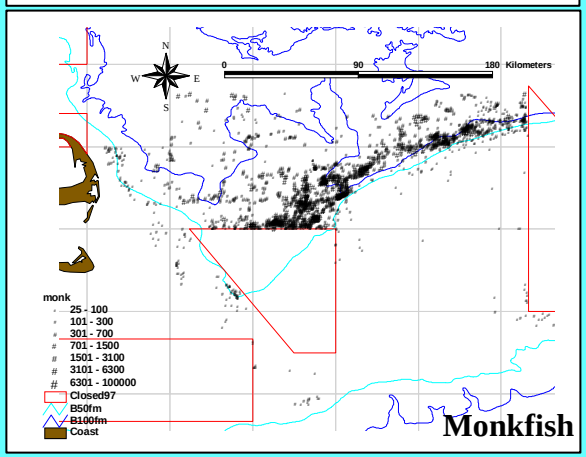
Yellowtail Flounder



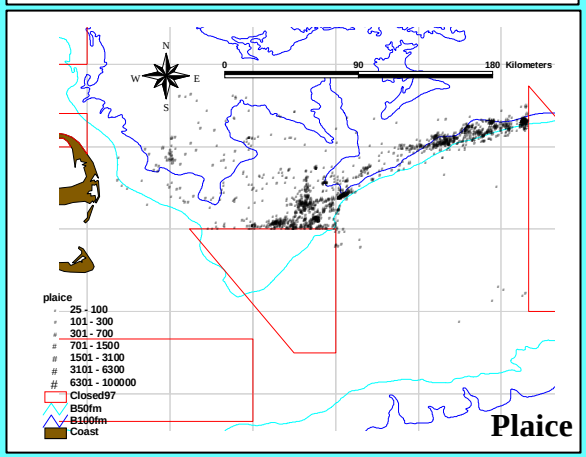
Cod



Haddock



Monkfish



Plaice

Spatial distribution of catch per tow by species for several groundfish species. Data reflect catches from individual tows recorded by a study fleet of trawlers based in New Bedford, Massachusetts.

Multispecies Fisheries

- **Although information requirements to do so may be high, there may be cases when spatially defined catch rights may help tune relative species catches without promoting discards.**
- **For example, a larger share of the overall quota for a relatively strong stock might be allocated to an area where a weak stock is less prevalent, thereby decreasing catch rates of the weaker stock and reducing the probability of discarding.**
- **The same argument may hold for juvenile bycatch. ITQs will provide little if any incentive to avoid bycatch of juveniles.**

Beyond the objective of the sole owner

- The impacts of one fishery on others or on other marine resources which provide value would not be internalized by the sole owner who would consequently have insufficient incentive to limit or eliminate those impacts.
- The assignment of property rights to fisheries (whether to sole owners or groups of individuals) may facilitate contractual negotiations to limit external impacts in a welfare maximizing way (Coase 1960).
- However, high transactions costs may prevent this from happening.

Joint Production

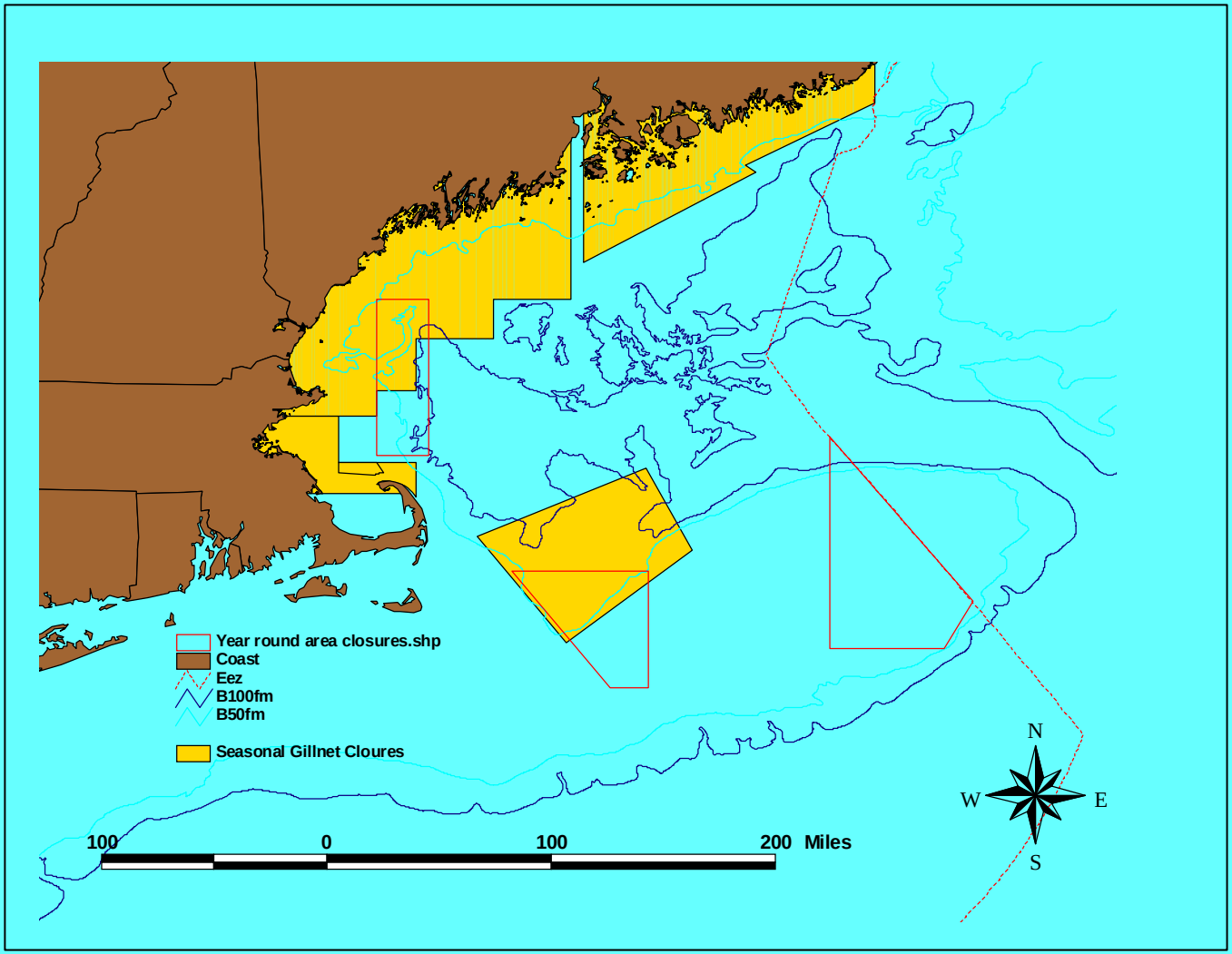
- **The need to managed multiple and conflicting uses of marine resources can be viewed as a problem of joint production for the social planner where production activities may involve multiple actors.**
- **Activities are compliments if an increase in output of one causes the incremental cost of producing another good to fall (economies) and are substitutes if they cause incremental costs to rise (diseconomies).**
- **Economies may be local or global**
- **The concept of economies of jointness can be extended to consider the net benefits of joint activities at different levels.**

Joint Production

- **Spatial separation of competitive products is indicated when diseconomies of jointness exceed the related economies of joint production at all production levels.**
- **This may suggest the need for zoning or perhaps year-round area closures.**
- **However, if diseconomies are local it may be preferable to limit the intensity of activities rather than separate them outright.**

Joint Production

- **Spatial heterogeneity in the distributions of different species or habitat may provide opportunities to coordinate resource exploitation spatially to avoid diseconomies associated with bycatch.**
- **This may not require prohibition of a fishery in an area but simply restrictions on gear or limits on the timing or amount of use of some gears in some areas.**
- **For example, fixed gear is not allowed in certain areas of the Gulf of Maine at certain times of year to avoid incidental catch of marine mammals, but mobile gear is still allowed in those areas.**



Areas marked in yellow are closed to gill nets at certain times of year to reduce entanglements of harbor porpoises and right whales.

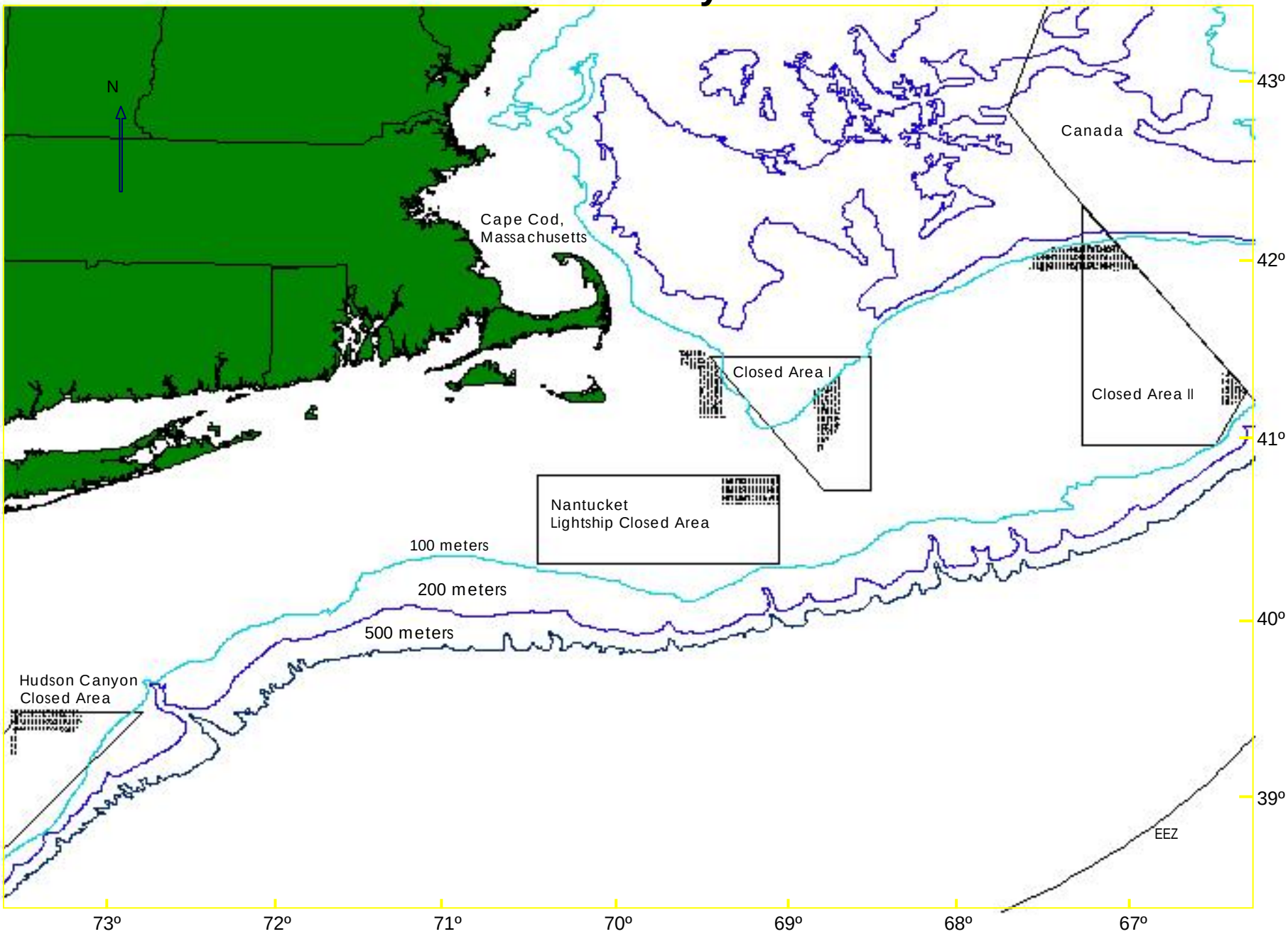
Habitat Protection

- **An individual quota system, and even sole ownership of a fishery, might not provide sufficient incentives to conserve habitat, particularly where benefits accrue to other fisheries.**
- **The 1996 reauthorization of the Magnuson-Stevens act requires fishery managers to identify and take steps to protect “essential fish habitat.”**
- **To optimize the productivity of the fishery, it may be necessary to specify the intensity of effort or the types of gears that can be used in discrete areas.**

Scallop Closed Area Access Program

- **The New England Fishery Management Council has authorized limited and tightly controlled access to scallops inside two closed areas on Georges Bank**
- **This special access program has allowed the scallop fleet to harvest tens of millions of dollars worth of scallops that would otherwise have been lost to predation by starfish and natural mortality.**
- **Vessels sacrificed ten days out of their individual effort quotas, for a trip limit of 10,000 pounds taken in four days on average.**
- **This reduced the fishery's total amount of dredge contact time with the bottom while increasing fishery revenues and decreasing operating costs**

2001 Video Survey Stations

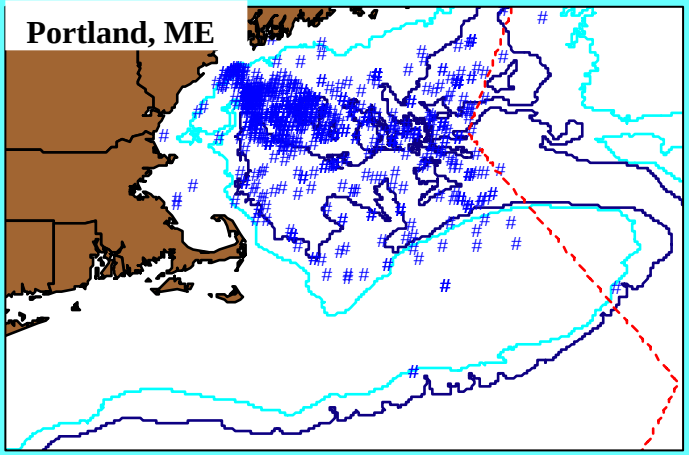


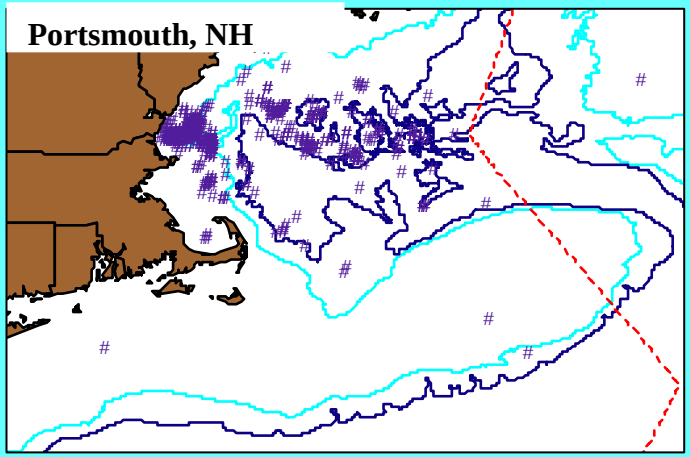
Scallop biomass in millions of lbs

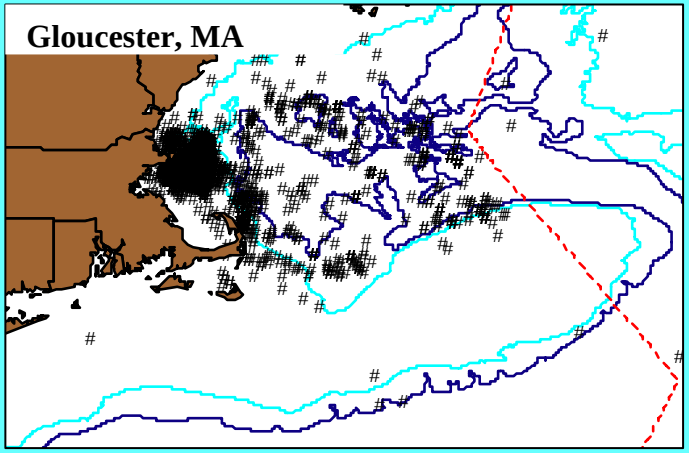
	NLSA	CAI	CAIIN
1999	14.60	7.78	9.40
2000	16.80	11.30	
Fishery	1.28	3.32	
2001	23.10	11.10	25.50
2002	28.30		

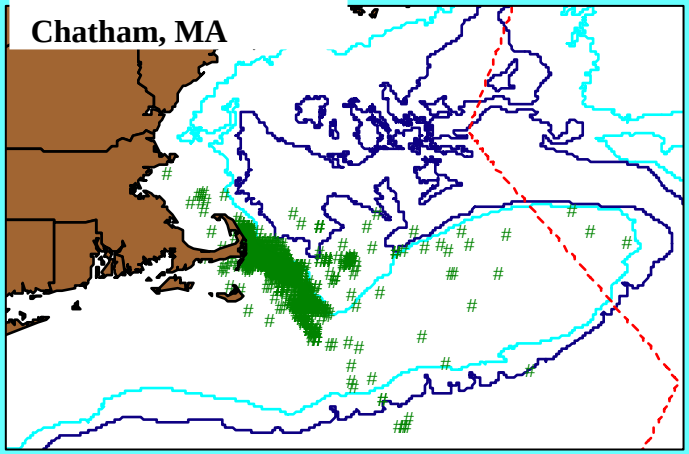
Fishing Communities

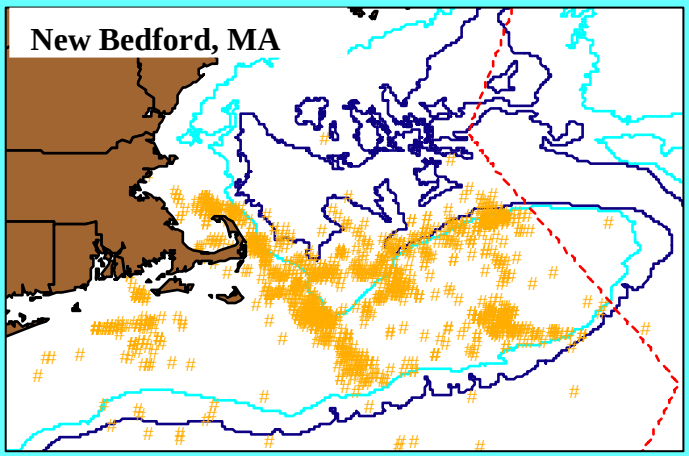
- **US law requires fishery managers to consider the effects on fishing communities of regulations and regulatory systems.**
- **Apparently the public values the continued involvement of these communities in the fisheries they have traditionally exploited.**
- **Requirements to harvest or land fish associated with particular quota shares in specific areas may resolve this problem, albeit at some cost in efficiency from the viewpoint of the industry.**

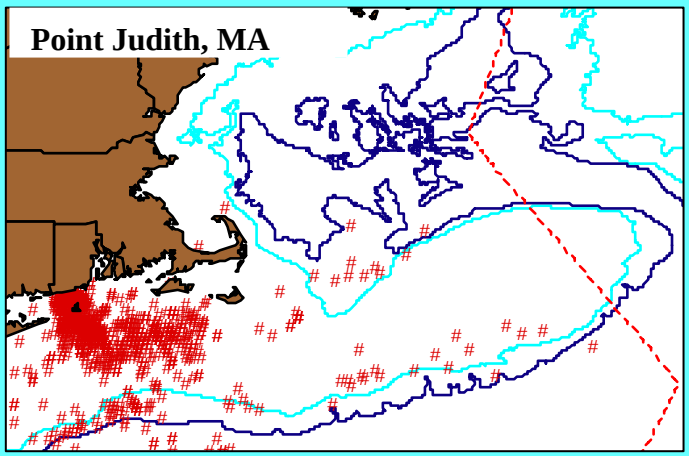












Distribution of groundfish trips taken in 2001 segregated by port of landing.

Attenuating Marine Property Rights Through Contracting

- **Congestion externalities and various inefficiencies resulting from suboptimal effort and catch distribution over space may be resolved directly by altering spatial quota allocations.**
- **Spatial delineation of harvest rights may facilitate contractual and market actions to reduce inefficiencies.**
- **For example, it might be feasible to use instruments similar to easements used to preserve open space. Environmental groups might purchase the quota for a sensitive area or simply buy easements that would prohibit certain activities (e.g., gears).**

Marine Zoning

- **If high transactions costs make contractual methods of resolving gear conflicts and external effects of fishing infeasible, zoning may be a preferred alternative.**
- **Distributional issues aside, zoning will be welfare improving if it reduces negative externalities by an amount greater than the costs of implementation and enforcement.**
- **However, zoning is a blunt instrument and can not be expected to equilibrate the marginal costs and benefits of various activities**

Adaptive Management

- **Spatial management may increase management costs. These costs must be weighed against gains.**
- **Spatial property rights may also provide useful information to policy makers about the efficiency of regulatory actions (such as changes to zoning).**
- **Spatial variation in quota prices for the same species will make the costs and benefits of these actions transparent.**
- **This can facilitate adaptive management if flexibility is built into the management system.**

Conclusions

- **Correctly defined property rights offer a means to achieve more optimal use of marine resources with a minimum of top down control.**
- **However, individual quota systems may still allow for the dissipation of rents across unpriced and uncontrolled margins. Even sole ownership may not prevent many welfare reducing activities.**
- **Defining fishery property rights in space, and use of zoning regulations to attenuate those rights in some cases, may provide an effective means to resolve many of these problems.**

Conclusions

- **The important question raised by what appear to missing property rights and resulting economic inefficiency is whether the value of correcting the problem is greater than the cost of doing so.**
- **This is an empirical question and a dynamic one since both the perceived value and the cost of internalizing externalities changes over time as a result of new information, technology, and changes in markets and the environment (Demsetz 1967).**

Conclusions

- **While implementing and enforcing spatial property rights and zoning may be expensive and imperfect, it is likely to yield useful information about the efficiency of regulatory actions (such as changes to zoning).**
- **Attempts should be made to build in flexibility to governance regimes that will allow adaptation of property rights over time as preferences, information and conditions change.**